MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 3, 2018/2019**

## DEM5028 – ENGINEERING MATHEMATICS 2

(Diploma in Electronic Engineering)

29 MAY 2019
9.00 a.m. – 11.00 a.m.
(2 Hours)

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**INSTRUCTIONS TO STUDENT**

1. This question paper consists of **2** pages (excluding the cover page and **2** pages of appendix).
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Write all your answers in the answer booklet provided.

## QUESTION 1 [25 MARKS]

a. Using suitable integration method, evaluate the following integrals.

i) $\int_0^1 x^2(x^3+3)^3 dx$

[6 marks]

ii) $\int 3xe^{2x} dx$

[7 marks]

b. Find the area of the region bounded by the curves $y = x^2 + 2$, and $x + y = 2$.

[5 marks]

c. Find the volume of the enclosed region bounded by $y = x - 1$ and $x^2 + y = 1$ that rotate at $y = -4$.

[7 marks]

## QUESTION 2 [25 MARKS]

a. Find the solution for the differential equation $y\frac{dy}{dx} = 2x$ .

[4 marks]

b. A differential equation is expressed as $\frac{dy}{dx} + y = e^x$. Find the final solution that satisfy the initial condition of $y(0) = 1$.

[9 marks]

c. Test either the series of $\sum_{n=1}^{\infty} \frac{8\sqrt{n}}{n^3}$ is convergence or divergence. (Must state the test used).

[3 marks]

d. Consider the power series $\sum_{n=1}^{\infty} \frac{nx^n}{3^n}$

i) Find the radius of convergence.

[4 marks]

ii) Find the interval of convergence.

[5 marks]

**Continued...**

## QUESTION 3 [25 MARKS]

a. Consider vector **a** = <–2, 2, –2> and **b** = <1, –3, –3>, find

i) Vector **b** x **a**.

[4 marks]

ii) The angle between **a** and **b**.

[4 marks]

iii) **b**.(**a** + 2**b**)

[6 marks]

b. Find the symmetric and parametric equations of the line that goes through the points $P(1, 2, 4)$ and $Q(3, -1, 6)$.

[6 marks]

c. Find the equation of the plane through the point (–2, 8, 10) and perpendicular to the line $x = 1 + t, y = 2t, z = 4 - 3t$.

[5 marks]

## QUESTION 4 [25 MARKS]

a. Given $f(x, y) = x^2 + \frac{1}{3}y^3 - 2xy - 3y$.

i) Find the critical point(s) of the function.

[7 marks]

ii) Determine whether the critical point(s) is a maximum, minimum or saddle point.

[8 marks]

b. A lamina that occupies a region between $x = -1, x = 1, y = 0$ and $y = 1$ has a density of $\rho(x, y) = x^2$.

i) Find its mass

[2 marks]

ii) Find its center of mass

[8 marks]

**End of page.**

# APPENDIX I: Formulae

## *Integration of common functions*

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C \qquad \int \frac{1}{x} dx = \ln|x| + C \qquad \int e^x dx = e^x + C \qquad \int a^x dx = \frac{a^x}{\ln a} + C$$

$$\int \sin x dx = -\cos x + C \qquad \int \cos x\, dx = \sin x + C \qquad \int \sec^2 x\, dx = \tan x + C \qquad \int \sec x \tan x dx = \sec x + C$$

$$\int \csc^2 x dx = -\cot x + C \qquad \int \csc x \cot x dx = -\csc x + C$$

## *Inverse Trigonometry*

$$\int \frac{1}{\sqrt{1-x^2}} dx = \sin^{-1} x + C$$

$$\int \frac{1}{x^2+1} dx = \tan^{-1} x + C$$

## *Pythagorean Identities*

$$\sin^2 x + \cos^2 x = 1$$

$$1 + \cot^2 x = \csc^2 x$$

$$1 + \tan^2 x = \sec^2 x$$

## *Integration by parts*

$$\int u dv = uv - \int v du$$

## *Areas Between Curves*

$$A = \int_a^b [f(x) - g(x)] dx$$

$$A = \int_c^d [w(y) - v(y)] dy$$

## *Volume by Washer*

$$V = \int_a^b \pi\left(\left[f(x)\right]^2 - \left[g(x)\right]^2\right) dx$$

$$V = \int_c^d \pi\left(\left[w(y)\right]^2 - \left[v(y)\right]^2\right) dy$$

## *Volume by Cylindrical Shells*

$$V = \int_a^b 2\pi x\left(f(x) - g(x)\right) dx$$

$$V = \int_c^d 2\pi y\left(w(y) - v(y)\right) dy$$

## *Linear Differential Equations:*

$$\frac{dy}{dx} + p(x)y = q(x);\ \mu y = \int \mu q(x) dx \Rightarrow y = \frac{1}{\mu}\int \mu q(x) dx, \qquad \text{where } \mu = e^{\int p(x) dx}$$

| | |
|---|---|
| **Divergence Test** | If $\lim_{n\to\infty} a_n \neq 0$, then $\sum a_n$ diverges. |
| **p-series** | The p-series $\sum_{n=1}^{\infty} \frac{1}{n^p}$ is convergent if p > 1 and divergent if $p \leq 1$. |
| **Limit Comparison Test** | Let $\sum a_n$ and $\sum b_n$ be series with positive terms such that $\lim_{n\to\infty} \frac{a_n}{b_n} = c$<br>If $0 < c < \infty$, then both series converge or both diverge. |
| **Alternating Series Test** | If the alternating series<br>$\sum_{n=1}^{\infty} (-1)^{n-1} b_n = b_1 - b_2 + b_3 - b_4 + \ldots \qquad b_n > 0$<br>Satisfies : i. $b_{n+1} \leq b_n$ for all $n$<br>ii. $\lim_{n\to\infty} b_n = 0$<br>then the series is convergent |
| **Ratio Test** | Let $\sum a_n$ be a series with nonzero terms such that $L = \lim_{n\to\infty} \frac{\lvert a_{n+1}\rvert}{\lvert a_n\rvert}$<br>a. Series converges absolutely if $L < 1$<br>b. Series diverges if $L > 1$ or $L = \infty$<br>c. No conclusion if $L = 1$ |

***Quadratic formula*** $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

***Vector***

The length of the vector $\mathbf{a} = < a_1, a_2, a_3 >$ is $|a| = \sqrt{{a_1}^2 + {a_2}^2 + {a_3}^2}$.

If $\theta$ is the angle between the vector **a** and **b**, then $\mathbf{a.b} = |\mathbf{a}||\mathbf{b}|\cos\theta$ & $|\mathbf{a} \times \mathbf{b}| = |\mathbf{a}||\mathbf{b}| \sin\theta$

***Cross Product*** $\mathbf{a} \times \mathbf{b} = \begin{vmatrix} i & j & k \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix} = \begin{vmatrix} a_2 & a_3 \\ b_2 & b_3 \end{vmatrix} i - \begin{vmatrix} a_1 & a_3 \\ b_1 & b_3 \end{vmatrix} j + \begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix} k$

***Equation of Line***

Vector equation: $r = r_0 + tv$ Parametric equation: $x=x_0+at$, $y=y_0+bt$, $z=z_0+ct$

***Equation of Plane*** $< a, b, c >< x - x_0, y - y_0, z - z_0 >= 0$

***The Chain Rule***

Suppose that $z = f(x, y)$, where $x = g(t)$ and $y = h(t)$ $\Rightarrow$ $\dfrac{dz}{dt} = \dfrac{\partial f}{\partial x}\dfrac{dx}{dt} + \dfrac{\partial f}{\partial y}\dfrac{dy}{dt}$

***Second Derivatives Test***

Suppose that $f_x(a,b) = 0$ and $f_y(a,b) = 0$ [that is, $(a, b)$ is a critical point of $f$]. Let

$D = D(a,b) = f_{xx}(a,b) f_{yy}(a,b) - \left[f_{xy}(a,b)\right]^2$

a. If $D > 0$ and $f_{xx}(a,b) > 0$, then $f(a, b)$ is a local minimum.
b. If $D > 0$ and $f_{xx}(a,b) < 0$, then $f(a, b)$ is a local maximum
c. If $D < 0$, then $f(a, b)$ is a saddle point.

***Moments and Centers of Mass***

The **moment** about the ***x*-axis:** $M_x = \iint_D y\rho(x,y)dA$

The **moment** about the **y-axis:** $M_y = \iint_D x\rho(x,y)dA$

The coordinates $(\bar{x}, \bar{y})$ of the center of mass:

$\bar{x} = \dfrac{M_y}{m} = \dfrac{1}{m}\iint_D x\rho(x,y)dA$ $\bar{y} = \dfrac{M_x}{m} = \dfrac{1}{m}\iint_D y\rho(x,y)dA$

Where the mass: $m = \iint_D \rho(x,y)dA$

***Triple Integrals:*** $\iiint_B f(x,y,z)dV = \int_r^s \int_c^d \int_a^b f(x,y,z)dxdydz$

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# FINAL EXAMINATION

**TRIMESTER 3, 2018/2019**

## DET5088 – ANALOG ELECTRONICS 3

(Diploma in Electronic Engineering)

29 MAY 2019
9:00 AM –11:00 AM
(2 Hours)

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**INSTRUCTIONS TO STUDENT**

1. This question paper consists of 3 pages excluding the cover page and appendix.

2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided.

## QUESTION 1 [25 marks]

(a) Describe the function on operational amplifier. (3 marks)

(b) Sketch an ideal voltage follower and explain its main function. (4 marks)

(c) Explain the circuit diagram of an instrumentation amplifier. (3 marks)

(d) Distinguish between the passive filter and active filter. (4 marks)

(e) Describe any **FOUR (4)** advantages of an active filter. (8 marks)

(f) Thermal drift is one of the error component in the practical operational amplifier. Describe how to minimize this drift to reduce the error in the output voltage. (3 marks)

## QUESTION 2 [25 marks]

(a) Based on the simple block diagram shown in Figure 1, briefly explain the signals for $V_{in}$, $A$,$B$, $C$ and $V_{out}$ with aid of its waveform respectively. (9 marks)

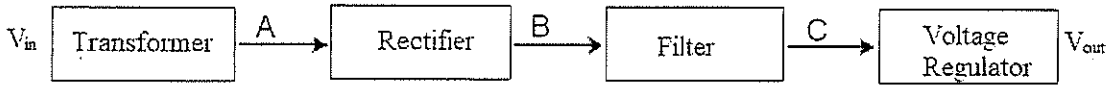


Figure 1

(b) Briefly explain the frequency stability in an oscillator. Then, describe the relationship between the quality factor and the frequency stability. (6 marks)

(c) Briefly explain the non-linear circuit. (4 marks)

(d) Sketch the diagram of a double-bounded comparator and explain its advantages over the bounded comparator. (6 marks)

**Continued ...**

## QUESTION 3 [25 marks]

(a) Figure 2(a) shows an amplifier circuit with $R_f$ = 3.3 kΩ and $C$ = 1 nF, while Figure 2(b) shows the input waveform of the amplifier circuit.

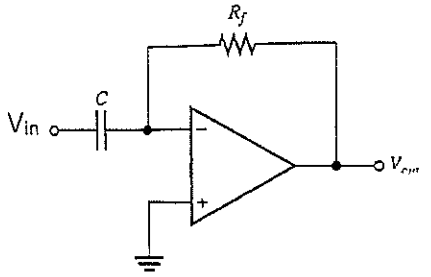


Figure 2(a)

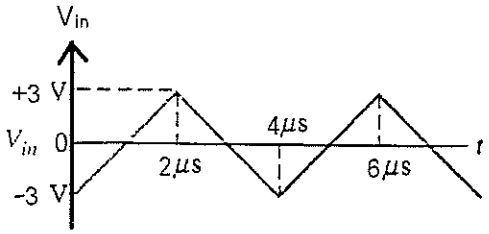


Figure 2(b)

i) Identify the type of op-amp application in Figure 2(a) (1 mark)

ii) Calculate the output voltage. (5 marks)

iii) Sketch the output voltage waveform. (4 marks)

(b) Determine the frequency for voltage gain, $|A|$ = 0.5 of a Butterworth 5th order low pass filter with cutoff frequency, $f_c$ = 20 kHz. (3 marks)

(c) The voltage transfer function of a 2-pole filter is given as,

$$H(S) = \frac{\frac{50000}{s}}{\frac{10000}{s} + 200 + s}$$

i) Determine the value of DC voltage gain ($K$), quality factor ($Q$) and oscillation frequency ($\omega_o$) (8 marks)

ii) Identify the type of the filter based on the transfer function. (1 mark)

(d) When the AC input voltage of a power supply changes, the input to the voltage regulator decreases by 4 V causing the output voltage of the regulator decreases by 0.2 V. The nominal output is 20 V. Determine the line regulation. (3 marks)

**Continued ...**

## QUESTION 4 [25 marks]

(a) Figure 3 shows a phase shift oscillator circuit which can accommodate an oscillation of 1 kHz.

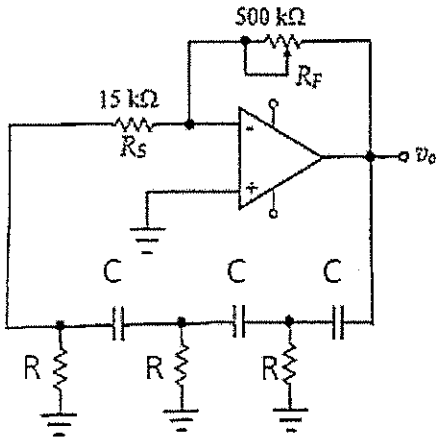


Figure 3

Based on the Figure 3, calculate the following:

i) Resistor value in the RC circuit if $C = 100$ nF. (3 marks)

ii) The value of feedback resistor ($R_F$), that need to be adjusted by using 500 kΩ potentiometer. (2 marks)

(b) When the DC supply voltage changes from $V_{DC} = \pm$ 12 V to ± 10 V, the change in input offset voltage per unit change in the dc supply voltage is 1 mV. Calculate the power supply rejection ratio. (4 marks)

(c) Design an inverting schmitt trigger comparator with the $V_0 = \pm 12$ V, $V_{UTP} = +7$ V, $V_{LTP} = -5$ V. Assume that $R_1 = 100$ kΩ. Then sketch the complete circuit diagram with its input and output waveforms respectively. (16 marks)

**End of Page.**

# APPENDIX

## Biquadratic voltage transfer function

| Filter type | $k_o, k_1, k_2$ | Voltage transfer function |
|---|---|---|
| Low-pass | 1, 0, 0 | $H_{LP}(s)=\frac{K\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$ |
| High-pass | 0, 0, 1 | $H_{HP}(s)=\frac{Ks^2}{s^2+(\omega_o/Q)s+\omega_o^2}$ |
| Band-pass | 0, 1, 0 | $H_{BP}(s)=\frac{K(\omega_o/Q)s}{s^2+(\omega_o/Q)s+\omega_o^2}$ |
| Band-reject | 1, 0, 1 | $H_{BR}(s)=\frac{K(s^2+\omega_o^2)}{s^2+(\omega_o/Q)s+\omega_o^2}$ |
| All-pass | 1, -1, 1 | $H_{AP}(s)=K\frac{s^2-(\omega_o/Q)s+\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$ |